NAVAL AVIATION VISION
2020

Naval Aviation Science and Technology

The overarching objective of the Naval Aviation Science and Technology (S&T) Program is to ensure Maritime Aviation Supremacy against a broad range of current and future threats.

A successful S&T program requires continuous exploration, leveraging, and prioritization of emerging technology advancements across multiple government and industry sectors. Perhaps more importantly, it requires coherent strategy, processes, and measures to maintain a balanced portfolio of technology solutions, aligned with, and relevant to, known and projected threats.

A high rate of return on Naval Aviation S&T investments will be assured by strengthening partnerships and establishing collective agreements on realistic technology trajectories, both near- and far-term. The NAE will use the Navy's four enduring roles: Assurance and Deterrence, Command of the Seas, Power Projection, and Homeland Defense/Security, as well as the four pillars of Sea Power 21, as strategic filters to guide its efforts and effect measurable increases in the safety, agility, and combat effectiveness of our Sailors and Marines.

The NCDP provides capabilities gap assessments. These gaps present opportunities for near- and mid-term technology "hooks"—places where new and existing technologies can be inserted to solve issues identified by NCDP analysis. In this way, the NCDP serves as a realistic point of departure for future S&T planning and investment. We will actively partner with the Office of Naval Research (ONR), Navy Warfare Development Command (NWDC), Defense Advanced Research Projects Agency (DARPA), Joint Service and National Agencies, private industry, and academia in order to *harvest, integrate,* and *rapidly transition* transformational, evolutionary, and disruptive technologies to dramatically extend the combat power of our Naval Forces. Measures of effectiveness and cost will be used to construct a compelling business case for S&T investment that readily translates to today's challenges and provides for transformational capabilities to 2030 and beyond.

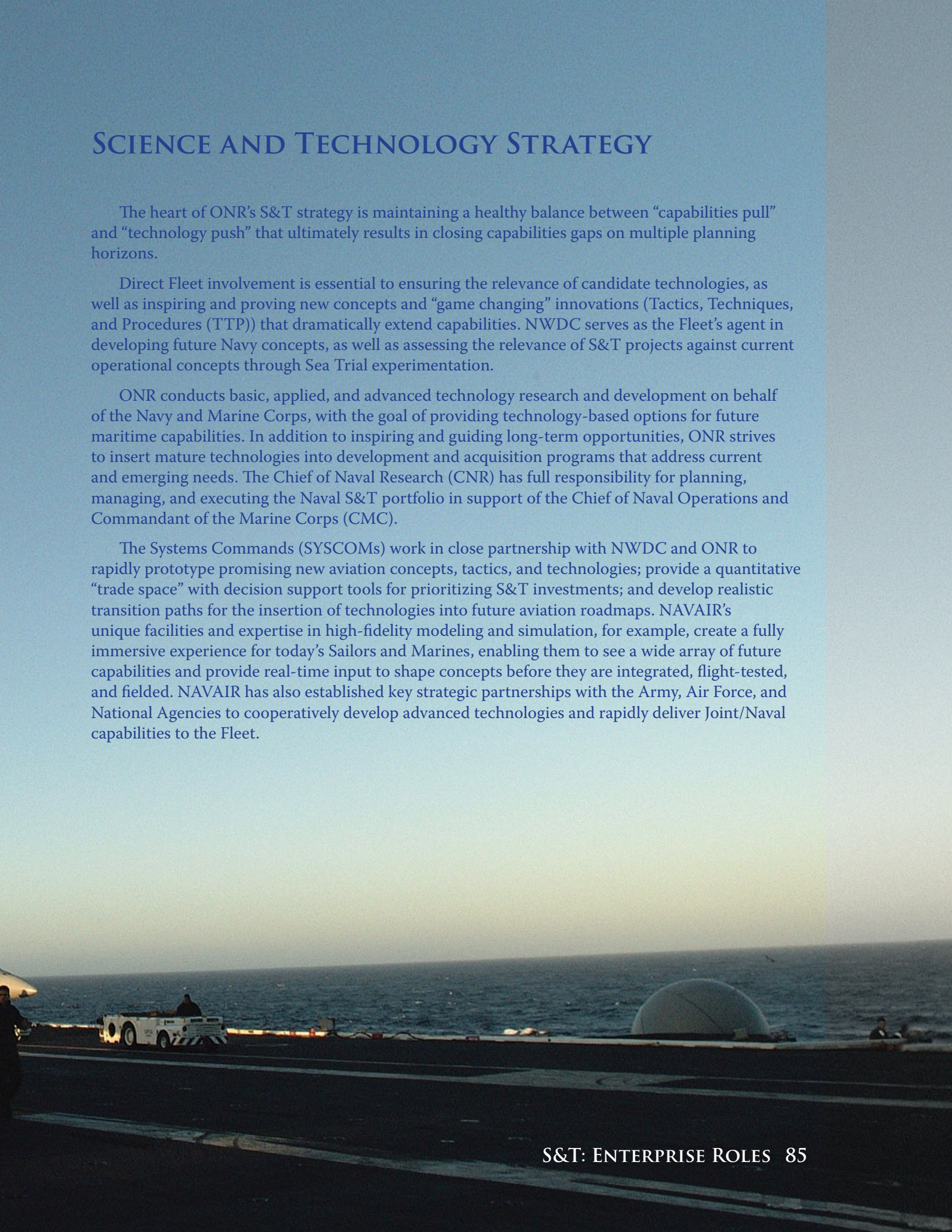
Science and Technology Strategy

The heart of ONR's S&T strategy is maintaining a healthy balance between "capabilities pull" and "technology push" that ultimately results in closing capabilities gaps on multiple planning horizons.

Direct Fleet involvement is essential to ensuring the relevance of candidate technologies, as well as inspiring and proving new concepts and "game changing" innovations (Tactics, Techniques, and Procedures (TTP)) that dramatically extend capabilities. NWDC serves as the Fleet's agent in developing future Navy concepts, as well as assessing the relevance of S&T projects against current operational concepts through Sea Trial experimentation.

ONR conducts basic, applied, and advanced technology research and development on behalf of the Navy and Marine Corps, with the goal of providing technology-based options for future maritime capabilities. In addition to inspiring and guiding long-term opportunities, ONR strives to insert mature technologies into development and acquisition programs that address current and emerging needs. The Chief of Naval Research (CNR) has full responsibility for planning, managing, and executing the Naval S&T portfolio in support of the Chief of Naval Operations and Commandant of the Marine Corps (CMC).

The Systems Commands (SYSCOMs) work in close partnership with NWDC and ONR to rapidly prototype promising new aviation concepts, tactics, and technologies; provide a quantitative "trade space" with decision support tools for prioritizing S&T investments; and develop realistic transition paths for the insertion of technologies into future aviation roadmaps. NAVAIR's unique facilities and expertise in high-fidelity modeling and simulation, for example, create a fully immersive experience for today's Sailors and Marines, enabling them to see a wide array of future capabilities and provide real-time input to shape concepts before they are integrated, flight-tested, and fielded. NAVAIR has also established key strategic partnerships with the Army, Air Force, and National Agencies to cooperatively develop advanced technologies and rapidly deliver Joint/Naval capabilities to the Fleet.



Science and Technology Current Readiness Initiatives

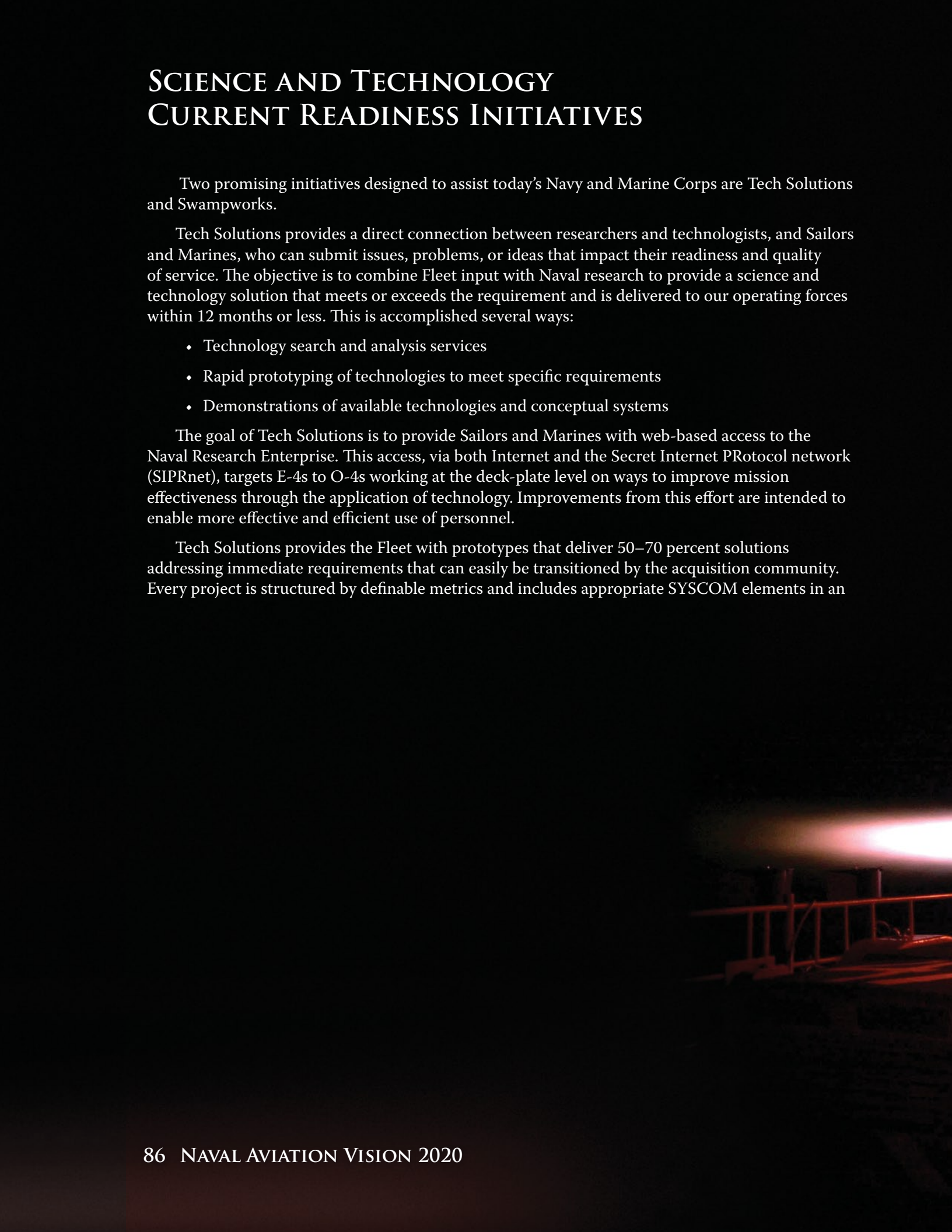
Two promising initiatives designed to assist today's Navy and Marine Corps are Tech Solutions and Swampworks.

Tech Solutions provides a direct connection between researchers and technologists, and Sailors and Marines, who can submit issues, problems, or ideas that impact their readiness and quality of service. The objective is to combine Fleet input with Naval research to provide a science and technology solution that meets or exceeds the requirement and is delivered to our operating forces within 12 months or less. This is accomplished several ways:

- Technology search and analysis services
- Rapid prototyping of technologies to meet specific requirements
- Demonstrations of available technologies and conceptual systems

The goal of Tech Solutions is to provide Sailors and Marines with web-based access to the Naval Research Enterprise. This access, via both Internet and the Secret Internet PRotocol network (SIPRnet), targets E-4s to O-4s working at the deck-plate level on ways to improve mission effectiveness through the application of technology. Improvements from this effort are intended to enable more effective and efficient use of personnel.

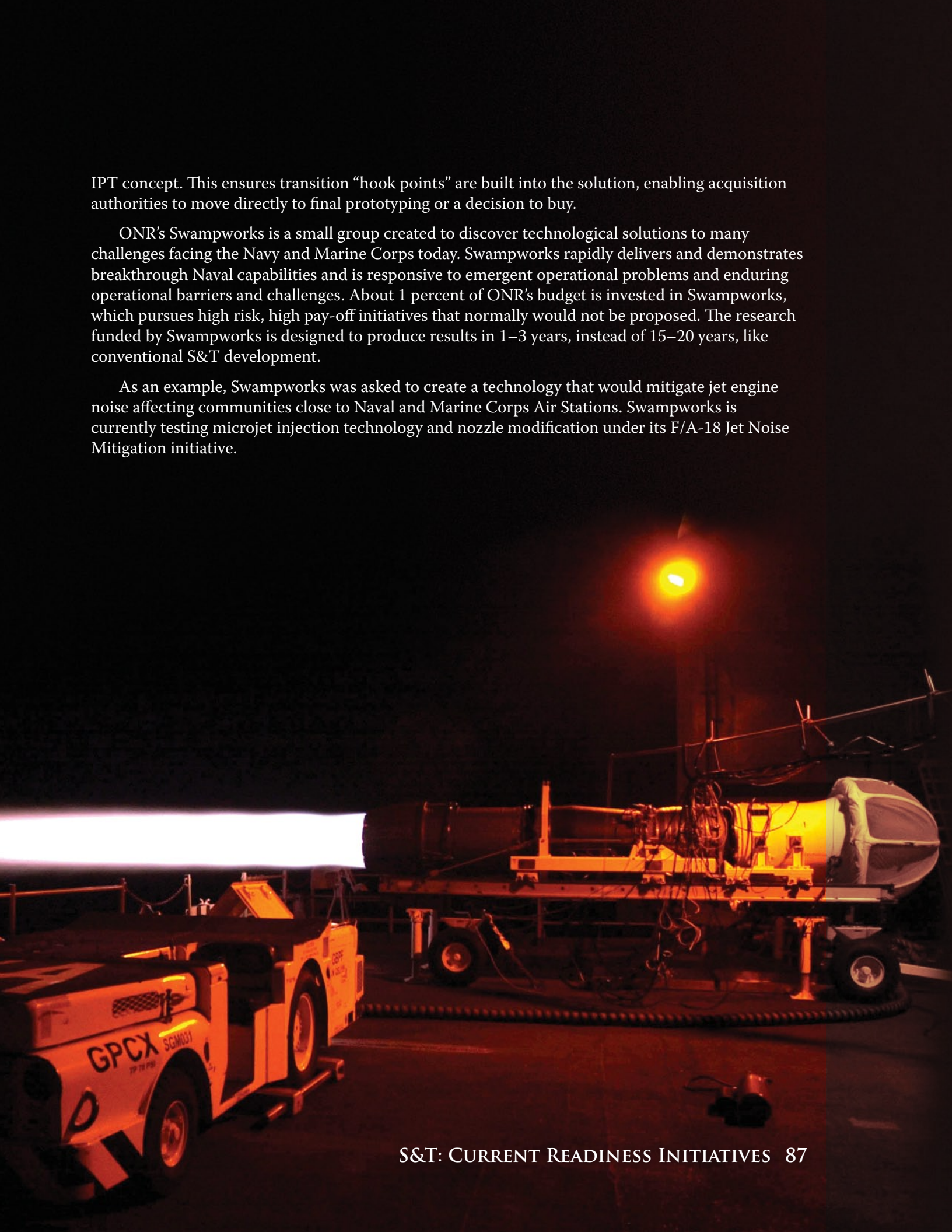
Tech Solutions provides the Fleet with prototypes that deliver 50–70 percent solutions addressing immediate requirements that can easily be transitioned by the acquisition community. Every project is structured by definable metrics and includes appropriate SYSCOM elements in an



IPT concept. This ensures transition "hook points" are built into the solution, enabling acquisition authorities to move directly to final prototyping or a decision to buy.

ONR's Swampworks is a small group created to discover technological solutions to many challenges facing the Navy and Marine Corps today. Swampworks rapidly delivers and demonstrates breakthrough Naval capabilities and is responsive to emergent operational problems and enduring operational barriers and challenges. About 1 percent of ONR's budget is invested in Swampworks, which pursues high risk, high pay-off initiatives that normally would not be proposed. The research funded by Swampworks is designed to produce results in 1–3 years, instead of 15–20 years, like conventional S&T development.

As an example, Swampworks was asked to create a technology that would mitigate jet engine noise affecting communities close to Naval and Marine Corps Air Stations. Swampworks is currently testing microjet injection technology and nozzle modification under its F/A-18 Jet Noise Mitigation initiative.



Science and Technology Future Readiness Initiatives

The "Next Navy and Marine Corps," the forces that will emerge over the next 15-30 years, is the target of ONR's Future Naval Capabilities (FNC) efforts, where a great deal of ONR's transformational initiatives reside. The FNC program has recently aligned with the NCDP, which establishes FNC requirements and priorities for FORCEnet, Sea Strike, Sea Shield, and Sea Basing. Keys to successful transformation are the strategic alignment of near-term S&T priorities derived from capabilities gaps, and the development of robust business partnerships between Warfighters, Requirements Officers, Acquisition Professionals, and private industry.

Approximately two-thirds of ONR's Advanced Technology Development funds and about 40 percent of its Applied Research funds are invested in the FNCs. The FNC process delivers maturing technology to acquisition program managers for timely incorporation into platforms, weapons, sensors, and process improvements. Each of the FNC focus areas is planned and reviewed by an integrated team with representatives from ONR, the appropriate PEO, the Navy and Marine Corps requirements community, and the Fleet/Force user community. This provides regular validation of the relevance of candidate technologies and strong buy-in and commitment to transition plans.

Intelligent Engine Demonstrator

The missions and systems contemplated for future unmanned vehicles present unique challenges to today's propulsion and power designs. Future UCAV and ISR missions will place greater electrical power demands on the engine, while also requiring reduced fuel consumption, increased specific thrust, and reduced cost of ownership. These challenges are compounded by requirements for high altitude operation, long mission endurance, survivability, and providing power and thermal management for a new generation of electrically insatiable high-resolution sensors, advanced Electronic CounterMeasures (ECM), *More Electric* subsystem architectures

(including electric flight control actuation), and—potentially—the desire to carry DEWs. Meeting these challenges simultaneously demands an integrated, vehicle-level design approach to satisfy the energy management requirements of both propulsion and payload. An integrated power module approach combining propulsion, electrical power, prognostics and engine diagnostics, and thermal management services is the basis of the FNC Intelligent Engine Demonstrator. Several distinctive technology areas are being pursued under both the FNC and Joint Government/Industry Versatile Affordable Advanced Turbine Engine (VAATE) programs.

Heavy Lift Replacement Helicopter (HLR) Program

HLR is the follow-on to the Marine Corps' CH-53E Heavy Lift Helicopter. It will have high-efficiency rotor blades with swept cathedral tips, a common engine system, survivability enhancements, a Joint interoperable modern cockpit, a low-maintenance elastomeric rotor head, and an improved structure and drive train. Commonality between other USMC aircraft in terms of engines and avionics will also greatly enhance the maintainability and deployability of the aircraft.

Improved rotor performance must be developed without increasing rotor diameter, which is limited by shipboard spotting constraints on today's amphibious assault ships. NAVAIR is conducting an investigation focused on improving the accuracy and efficiency of rotorcraft hover and forward flight performance in a project titled, "Heavy Lift Rotorcraft Advanced Aero Modeling." Under this investigation, NAVAIR is pursuing several performance-enhancing technologies such as non-linear twist distribution, advanced airfoils, unconventional tip planform geometries, increased blade number, passive high-lift devices, reconfigurable rotors, and active controls.

NAVAIR's heavy lift investigation will facilitate the design of advanced high-performance rotors through the development of a new class of practical, computational fluid dynamics-based engineering analysis and design tools. These tools will significantly reduce the cost, risk, and amount of wind tunnel time needed to optimize advanced rotor blade designs and substantiate their performance.

The "Navy & Marine Corps After Next"

The "Navy and Marine Corps After Next" is the operational force we will see in 15-30 years. On this planning horizon, ONR is conducting exploratory and advanced development research in multiple fields, especially in areas that are "Navy and Marine Corps-unique."

Unique Naval Aviation Technology Areas are fields in which Naval Aviation is the only significant U.S. sponsor. It is vital to keep such fields healthy to outpace our adversaries and avoid technological surprise. A broad U.S. Naval Aviation mission, accomplished in challenging operating environments, dictates unique technical requirements different from those of other air forces. ONR is investing in several Naval Aviation technologies, including:

- Materials
- Structures
- Flying Qualities and Performance
- Propulsion and Power Systems
- Ship/Ground Aviation Systems
- Avionics
- Weapons Engineering/Energetics
- Human Systems

Sea Strike Initiatives and Areas of Interest

High Speed Weapons (HSWs)

Naval Aviation planners are interested in the development of High Speed Weapons (HSWs) capable of operating from high supersonic speeds (Mach 3-4) to hypersonic speeds (Mach 5 and above). Typically viewed as long-range weapons, ONR has invested funds in developing the structures, materials, propulsion, and inlet/nozzle technologies needed for such highly integrated, volume-constrained systems. Development of these weapon systems supports the National Aerospace Initiative (NAI) mission of sustaining America's aerospace leadership with an integrated, capability-focused, national approach enabling High Speed/Hypersonic (HS/H) flight.

The immense velocities achieved by HSWs will reduce the kill-chain time for Time Sensitive Strike (TSS) and increase the probability of penetrating hard and deeply buried targets. Within a decade, we expect to improve the CSG's current precision-firing capability from a few hundred aim points per day to over five times that many. Commanders on the ground will gain a tremendous advantage from the enhanced strike ability of sea-based aircraft. When combined with the other elements of CSGs and ESGs, it will allow ground commanders to integrate fires with maneuver, enhancing the strategic deterrence of our forward-deployed Naval forces.

Directed Energy Weapons (DEWs)

Advancements in High-Power Microwaves (HPMs) and High Energy Lasers (HELs) have created a new class of weapons systems known as Directed Energy Weapons (DEWs). DEW systems will precipitate a revolution in future engagements, employments, and concepts of operations.

HPMs flood target areas with energy, allowing multiple and simultaneous target engagements. HPMs affect the target internally, by electrical disruption. Conversely, High Energy Lasers (HELs) provide precise, long-range laser targeting for surgical strikes, effective whether the laser is on the ground, at sea, in the air, or in space. Future manned and unmanned aircraft can be expected to deploy DEWs and targeting systems.

HELs offer great promise for ASW and Anti-Surface Warfare (ASUW) missions. Because HELs offer extremely precise targeting, hostile craft can be engaged even with friendly forces in the vicinity. Solid-state lasers facilitate multiple target engagements without the requirement to rearm, and when coupled with high-performance gimbal systems, provide extremely rapid response. And because lasers are invisible, the enemy will not immediately know the origin of the attack.

Using HELs for Anti-Air Warfare (AAW) could change the balance of air power, helping the U.S. achieve airspace dominance offensively. They could also be used defensively to destroy incoming air-to-air missiles, expanding the role of non-fighter aircraft during wartime operations and eliminating the need for fighter escorts.

Unmanned Aerial Vehicles (UAVs)

UAVs have a key role in the future of Naval Warfare as force-multipliers in the areas of Knowledge and Information Superiority, Persistent Surveillance, and TSS. ONR is pursuing multiple technology paths across a family of UAVs, by exploiting existing service UAVs, leveraging available industry sensor packages, and focusing on Naval unique and essential capabilities for persistent ISR.

Naval unique capabilities include shipboard operations and support for broad-area maritime surveillance. Naval essential capabilities, harvested from the Joint Services, government agencies, and industry, include technologies that increase situational awareness, improve battlespace management, and facilitate strike support.

The J-UCAS program is a DARPA, Navy, and Air Force effort to demonstrate the technical feasibility, military utility, and operational value of a networked system of high performance, weapons-capable Unmanned Aerial Vehicles. These UAVs would be designed to effectively and affordably execute 21st century combat missions, including DEAD/SEAD and surveillance, all within the emerging architecture of global command and control. J-UCAS combines DARPA's Navy and Air Force UCAV programs.

Sea Shield Initiatives and Areas of Interest

Theater Air and Missile Defense (TAMD)

TAMD forms a protective umbrella against aircraft and ballistic/cruise missile threats. The protection extends over the horizon or deep inland, from ground level to the upper atmosphere.

The CEC will network digital radar data from the E-2D *Advanced Hawkeye* and surface units in the battle force. When CEC and Marine Air Ground Task Force (MAGTF) capabilities are networked with the new over-the-horizon Surface-to-Air (SM-5) missile, an integrated and seamless air defense is created that can engage airborne targets at long range, over land and sea. The ability to form a Single Integrated Air Picture (SIAP), using Joint track data, will tremendously improve tactical decision speed, accuracy at extended ranges, and increase the number of engagement opportunities.

TAMD also allows us to transform our force doctrine. Commanders can reassign manned aircraft from defensive air patrol duties to strike missions, and vice versa. Another option would be to reassign *AEGIS* guided-missile destroyers from close-in force defense to distant ballistic missile defense stations, or to conduct precision surface-fire strikes. With the development of the Volume Search Radar, extended-range air defense will be enhanced. It provides integrated, hemispheric search coverage in the battlespace and will be installed on the *CVN 21*-class and the next generation of surface ships.

Sea-based Ballistic Missile Defense (BMD) systems will exploit the existing infrastructure of Naval radars and missile launchers, lending flexibility to theater and homeland missile defense operations. FORCEnet will defend against theater-range missiles by linking our sea-based interceptor missiles to a space- and air-based sensor network and C^2 systems. *USS LAKE ERIE* (CG-70) has conducted several BMD tests and launchings, making ballistic missile defense a near-term reality.

Littoral Sea Control

Littoral Sea Control assures access and maneuvering freedom for Joint forces deploying from the sea base. We will defeat anti-access assets such as small, "swarming" surface craft, quiet diesel submarines, and sea mines through a combination of surface, subsurface, and aviation assets. The command and control of such missions will be vastly improved through netted assets that link our attack forces to sensors, decision aids, and displays.

Anti-Submarine Warfare (ASW)

The objective of ASW is to gain maritime superiority by finding, destroying, and, when necessary, avoiding enemy submarines. The modern diesel submarine, far quieter than its predecessors, is well suited for the mission of area denial. We can expect our adversaries to use diesel submarines in the littorals, where shallow waters are noisy and cluttered. Consequently, we must leverage advanced technologies to improve wide-area surveillance, detection, localization, tracking, and attack of underwater threats.

Manned and unmanned aircraft—by virtue of their speed, area of coverage, versatility and payload—will continue to be indispensable against the submarine threat. The P-3C, with its Anti-Surface Warfare Improvement Program (AIP), and the P-8A MMA will fulfill multiple roles in ASW and ASUW to assist CSG and ESG Commanders. The Navy is developing the ALFS to increase the acoustic capabilities of ship-based MH-60R helicopters. The Automatic Radar Periscope Detection System, which can be installed on aircraft and surface ships, will be used to detect exposed enemy periscopes. Over the long term, research efforts will be focused on developing active and passive EO systems for manned aircraft and UAVs.

Mine Countermeasures (MCM)

Effective MCM keeps the seaways open by neutralizing enemy mines that hinder free movement. We will work to develop new mine detection and clearance systems, including systems organic to forward-deployed combat ships and the Littoral Combat Ship (LCS). Both the MH-53E and organic MH-60S AMCM helicopters will employ various mine hunting, sweeping, and neutralization weapon systems to rapidly localize and mitigate the sea mine threat to Naval and commercial shipping. These sophisticated, networked craft will patrol air, surface, and sub-surface mediums. New MCM technologies and advanced detection systems, such as multi-spectral electro-optics and laser detection, may be deployed on patrol aircraft, helicopters, and UAVs to support future Naval operations.

Airborne Mine Countermeasures Systems (AMCM)

Carried into combat by MH-60S *Seahawk* helicopters, five next-generation AMCM weapon systems will provide the CSG/ESG with an organic capability to locate and neutralize sea mines. These systems include the AQS-20A mine hunting sonar, Airborne Laser Mine Detection System (ALMDS), Airborne Mine Neutralization System (AMS), Rapid Airborne MIne Clearance System (RAMICS), and Organic Airborne and Surface Influence System (OASIS). Collectively, they will facilitate unfettered operations between the shallow water littoral environment and blue water. These new capabilities, organic to deployed Naval forces, will work in conjunction with other MCM assets, and increase our Navy's ability to maneuver in potentially mined areas during combat.

Homeland Defense/Security

Sea Shield extends homeland security to the fullest extent through a national effort that will integrate forward-deployed Naval forces with the Joint Services, civil authorities, intelligence, and law-enforcement agencies.

Working with the newly established U.S. Northern Command, we will identify, track, and intercept dangers long before they threaten our homeland. This will extend the security of the United States far seaward, taking advantage of the time and space afforded by Naval forces to shield our nation from impending threats. Naval aircraft such as the P-8A MMA, the E-2C *Hawkeye,* the E-2D *Advanced Hawkeye*, and the BAMS UAV, will provide comprehensive situational awareness to cue allied and Joint service interceptors. Additional concepts involve installing advanced sensors on blimps and other Lighter Than Air (LTA) vehicles.

We are also exploring ways to process and display the vast quantities of intelligence data within the maritime battlespace. To create actionable "Maritime Domain Awareness," we are developing automated systems that will assimilate, correlate, and display the data, then share the information with the relevant authorities. This concept embodies FORCEnet and will provide global reach into the GIG-ES to ensure the timely interdiction of suspicious vessels and aircraft.

Force Entry Enabling

Force Entry Enabling is a key component of Sea Shield. Our future adversaries know from OEF/OIF that it is in their best interest to strike before U.S. forces enter the battlespace. To do this, they will need a strong ISR capability coupled with the ability to strike U.S. logistics centers. Sea Shield assets counter this threat by providing vital escorting and traditional sea control roles. Naval Aviation will operate in concert with Sea Shield forces to engage the enemy as rapidly as possible and provide vital ASW and mine countermeasures support with MPA, helicopters, and UAVs.

Sea Basing Initiatives and Areas of Interest

Airships

Recent advancements in materials and propulsion technologies make airships and LTA vehicles a realistic, cost-effective, low-risk option for Force Protection and Logistics/Heavy Lift Sea Basing. Airships are capable of maintaining a stationary orbit and providing constant coverage and continuous situational awareness for deployed forces. Supporting the Navy's Sea Base, airships could transport materiel and equipment across international distances, possibly landing on water and mitigating the challenges of limited forward basing. Airships are stable, survivable, and cost-efficient to operate.

Seaplanes

With their ability to land and take off from both land and water, manned and unmanned seaplanes are promising candidates for connecting the Sea Base with the shore. This amphibious transport aircraft would be based on the synergy between extreme Short TakeOff and Landing (STOL) aerodynamics and advanced planing hydrodynamics. Other technologies would include advanced propulsion, sensors and processing, and composite structures. Seaplanes would boast a payload weight and volume similar to the C-130 and could operate from both water and unimproved airfields.

Sea Trial Initiatives and Areas of Interest

Sea Trial streamlines and integrates the Navy and Marine Corps experimentation process, putting the Fleet at the heart of innovation. Its aim is to speed prototyping, enrich concept development, and coordinate experimentation more fully. Under Sea Trial, we will "push" forward basic research, science, and technology, and "pull" from documented warfighting requirements in order to develop and acquire new systems. Our research, science, and acquisition communities will monitor and support promising technologies, then incorporate these technologies into advanced systems that we will deliver to the Fleet Warfighter.

Initiatives already conducted under the umbrella of Sea Trial include Link 16 upgrades, P-3 Satellite Communication (SATCOM) and acoustic data links, precision fires data links, and the Global Hawk Maritime Demonstration. Sea Trial is currently emphasizing the testing of netted data and information systems in support of the CNO's goal of a networked Naval force. Other areas of interest include accelerating the prototyping and experimentation of unmanned Naval vehicles (air, surface, and sub-surface).

The Sea Trial process will develop enhanced warfighting capabilities for the Fleet by more effectively integrating the thousands of talented and energetic experts, military personnel, and civilians who serve throughout our Navy and Marine Corps. Working together, they will fulfill the promise of Sea Power 21.

The Fleet's Role

Although the Commander, U.S. Fleet Forces Command (CFFC) provides the overall guidance for Sea Trial, and the Navy Warfare Development Command (NWDC) serves as Project Coordinator, the operational Fleets play major roles in the program. Second Fleet supports Sea Strike and Sea Basing initiatives and Third Fleet supports Sea Shield. The Naval Network Warfare Command (NETWARCOM) manages all FORCEnet-related Sea Trial initiatives. The Fleets are each responsible for their respective experimentation plans and Fleet collaboration teams established at each unit will lead the Sea Trial process.

Fleet Support

The Office of the Chief of Naval Operations (OPNAV) and the SYSCOMs will integrate Sea Trial into various acquisition strategies. Risk will be managed by thoroughly developed CONOPS and early, frequent, interaction with the Fleet customer, to "get it right" prior to Operational Evaluation (OPEVAL). Supporting this effort are state-of-the-art Test and Evaluation facilities at Point Mugu, China Lake, Lakehurst, and Patuxent River used to demonstrate promising Naval Aviation technologies. At these warfare centers, reconfiguration of test aircraft, weapons, and launch and recovery equipment as well as high-fidelity modeling and simulation, allow the Fleet to see a wide array of future capabilities. Restricted-use airspace and weapons ranges support early Fleet experimentation, demonstration, and validation of systems, weapons, and aircraft still under development. Fleet Battle Experiments (FBEs) provide a testing environment for developmental systems.

ONR, DARPA, and Joint service technology and acquisition programs support Sea Trial. Ongoing rapid prototyping and technology-insertion efforts continue through the Advanced Technology Review Board (ATRB), providing a formal means to review capabilities, requirements, and technology approaches.

Impacts of Sea Trial

Because it is Fleet-led, Sea Trial will focus innovation on Warfighter requirements and concerns. It will facilitate access to testing environments where Warfighters can verify doctrine and tactics, and their early involvement will correct deficiencies and manage risk.

NWDC will integrate war gaming, experimentation, and technology to expedite the maturation of new systems via spiral development and rapid prototyping. NWDC will work with OPNAV resource sponsors like N78 to align priorities and secure funding commitments to convert developmental programs, spawned by Sea Trial, into Programs of Record, supported by the Program Objective Memoranda (POM) budget.

Sea Trial is the centerpiece of Navy and Marine Corps experimentation that will fill capabilities gaps and convert new technologies into warfighting instruments.

Research Partnerships

ONR established the FNC program to balance near-term and long-term requirements. Under this process, the Department of the Navy applies approximately half of its S&T budget to over 200 programs that address the Fleet's near-term operational requirements. Aviation Program Managers, acting as transition sponsors, are closely linked to individual FNC programs to ensure the Fleet receives these capabilities quickly. ONR also conducts exploratory and advanced development research in multiple fields, including aeronautics, avionics, air vehicle propulsion, solid and air breathing missile propulsion, gun propulsion, missile and gun projectile guidance and control, warheads, fuse devices (safe and arm), fire control, and targeting.

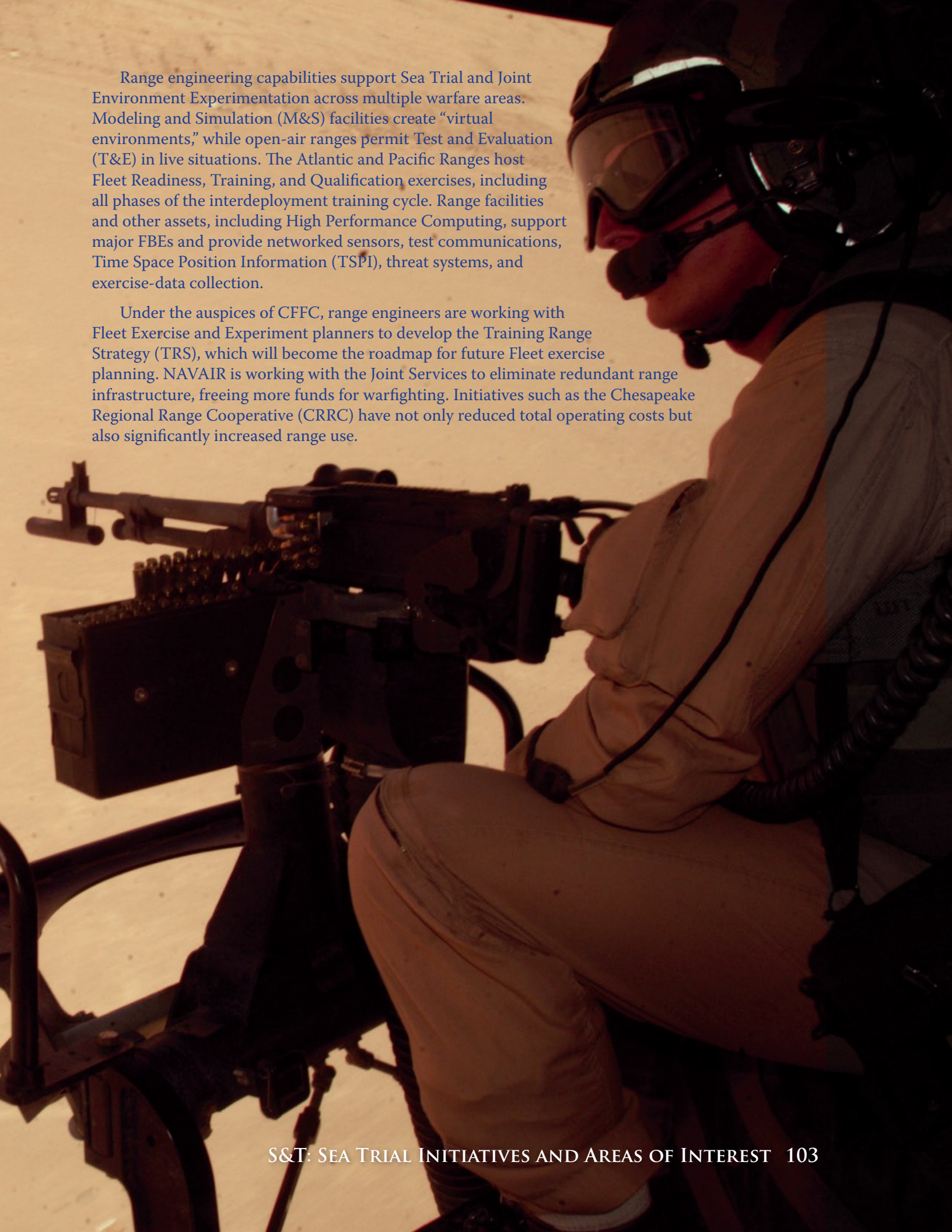
The Advanced Concept Technology Demonstration (ACTD) process, run jointly by DARPA and ONR, allows the Fleet to evaluate advanced technologies that can improve warfighting capability. The Fleet tests the ability of mature technologies to solve immediate problems, and assesses their operational performance. These demonstrations also provide a basis to evaluate and refine operational requirements, develop corresponding CONOPS, and ultimately produce a sound understanding of the application and utility of new technologies. Finally, ACTD processes seek to provide "residual" operational capabilities as an interim solution prior to procurement.

Co-Evolution and Spiral Development

Co-evolution is the simultaneous development of the ways we organize, equip, and fight. Spiral development is the process whereby researchers seek incremental advances that build upon one another to achieve greater results. This facilitates technology insertion, eliminates systemic problems with interoperability, and maintains the focus on improving combat capabilities, creating a closer link between technology development and operational implementation. Spiral development includes the evolution of associated command concepts such as doctrine, TTP, organizational and personnel arrangements, information flow, systems, materiel, education, training, and logistics.

Test Ranges

Test ranges support the Sea Trial concept through test and experimentation. They foster the development and Fleet introduction of advanced Naval Aviation technologies and concepts. Under a unified national command structure, the Atlantic and Pacific RDT&E ranges provide a vision of what is possible, and a single point of entry for training and experimentation.



Range engineering capabilities support Sea Trial and Joint Environment Experimentation across multiple warfare areas. Modeling and Simulation (M&S) facilities create "virtual environments," while open-air ranges permit Test and Evaluation (T&E) in live situations. The Atlantic and Pacific Ranges host Fleet Readiness, Training, and Qualification exercises, including all phases of the interdeployment training cycle. Range facilities and other assets, including High Performance Computing, support major FBEs and provide networked sensors, test communications, Time Space Position Information (TSPI), threat systems, and exercise-data collection.

Under the auspices of CFFC, range engineers are working with Fleet Exercise and Experiment planners to develop the Training Range Strategy (TRS), which will become the roadmap for future Fleet exercise planning. NAVAIR is working with the Joint Services to eliminate redundant range infrastructure, freeing more funds for warfighting. Initiatives such as the Chesapeake Regional Range Cooperative (CRRC) have not only reduced total operating costs but also significantly increased range use.